

The Biologist



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Phi Sigma

BIOLOGICAL HONOR SOCIETY

"The object of Phi Sigma is to promote interest in biological research. Although originally designated as an honorary biological research society, it should not be considered as a working guild of biologists interested in research. In effect, election to Phi Sigma should be an opportunity for better work, rather than merely election to an honorary society."

Mile Posts:

- 1915 March 17, Alpha Chapter organized, Ohio State University, Columbus.
- 1916 May, Central Governing Body organized, BIOLOGIST first issued.
- 1917 June, last War-time BIOLOGIST issued.
- 1921 February, BIOLOGIST revived.
- 1924 December, First National Meeting, Constitution revised, Washington, D.C.
- 1925 December, Second National Meeting, First Science Program, Kansas City.
- 1926 December, Third National Meeting, Second Science Program, Philadelphia.
- 1927 December, Third Science Program, Nashville.
- 1928 December, Fourth National Meeting, Coat-of-Arms adopted, Fourth Science Program, New York.
- 1930 January, Council Meeting, Ritual Revised, Norman, Okla.
December, Fifth National Meeting, Fifth Science Program, Cleveland.
- 1931 Phi Sigma Letters Registered, U. S. Patent Office.
- 1932 December, Sixth Science Program, Atlantic City.
- 1933 June, Sixth National Meeting, Seventh Science Program, Chicago.
- 1935 December, Seventh National Meeting, Eighth Science Program, St. Louis.
- 1937 December, Eighth National Meeting, Ninth Science Program, Indianapolis.
- 1939 December, Ninth National Meeting, Tenth Science Program, Silver Anniversary, Ohio State University, Columbus.
- 1942 December, Tenth National Meeting, Dallas, Texas.

Expansion:

The Constitution provides that: "An active chapter may be established in any institution of learning which requires for graduation the equivalent of four years of collegiate work, and which is equipped with facilities for research work. - - - Any petitioning group must be active for at least one year before it may be granted a charter."

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OF ALL ACTIVE AND INACTIVE CHAPTERS

*The list of chapter officers for this school year will be found in the
CHAPTER NEWS section of Vol. XXIV, No. 1.*

ALPHA

Ohio State University, Columbus, Ohio, founded March 17, 1915, (Inactive).

BETA

University of Michigan, Ann Arbor, Michigan, founded June 3, 1916.

DELTA

University of Maine, Orono, Maine, founded January 27, 1917, (Inactive).

EPSILON

University of Denver, Denver, Colorado, founded March 5, 1917.

ZETA

University of Wisconsin, Madison, Wisconsin, founded May 30, 1917.

ETA

University of Akron, Akron, Ohio, founded April 20, 1921.

THETA

Michigan State College, East Lansing, Michigan, founded April 9, 1921, (Inactive).

IOTA

Washington University, St. Louis, Missouri, founded May 28, 1921.

KAPPA

University of Kansas, Lawrence, Kansas, founded May 31, 1921.

LAMBDA

Montana State University, Missoula, Montana, founded May 4, 1921.

MU

University of California, Berkeley, California, founded April 27, 1922.

NU

Washington and Jefferson College, Washington, Pennsylvania, founded May 11, 1922.

XI

University of Nebraska, Lincoln, Nebraska, founded May 3, 1934, (Inactive).

OMICRON

University of North Dakota, Grand Forks, North Dakota,
founded May 26, 1924, (Inactive).

PI

Emory University, Georgia, founded January 3, 1925.

RHO

University of Illinois, Urbana, Illinois, founded March 28, 1925.

SIGMA

University of Florida, Gainesville, Florida, founded December 4, 1925.

TAU

Duke University, Durham, North Carolina, founded March 4, 1926.

UPSILON

Miami University, Oxford, Ohio, founded May 7, 1926.

PHI

University of New Hampshire, Durham, New Hampshire, founded May 21, 1926.

CHI

Montana State College, Bozeman, Montana, founded February 11, 1927.

PSI

University of Washington, Seattle, Washington, founded April 7, 1928.

OMEGA

University of Oklahoma, Norman, Oklahoma, founded March 24, 1928.

ALPHA ALPHA

University of Southern California, Los Angeles, California, founded May 17, 1930.

ALPHA BETA

Mount Union College, Alliance, Ohio, founded May 17, 1928.

ALPHA GAMMA

University of South Dakota, Vermillion, South Dakota, founded May 15, 1928, (Inactive).

ALPHA DELTA

Lawrence College, Appleton, Wisconsin, founded March 7, 1929, (Inactive).

ALPHA EPSILON

University of Pittsburgh, Pittsburgh, Pennsylvania, founded March 23, 1929.

ALPHA ZETA

College of William and Mary, Williamsburg, Virginia, founded April 19, 1930, (Inactive).

ALPHA ETA

Oklahoma Agricultural and Mechanical College, Stillwater, Oklahoma, founded March 13, 1930.

ALPHA THETA

State College of Washington, Pullman, Washington, founded May, 1930.

ALPHA IOTA

Bucknell University, Lewisburg, Pennsylvania, founded January 9, 1932.

ALPHA KAPPA

Hunter College, New York City, founded January 8, 1932.

ALPHA LAMBDA

University of Utah, Salt Lake City, Utah, founded February 13, 1932.

ALPHA MU

University and State College of Oregon, Eugene-Portland-Corvallis, Oregon, founded November 18, 1933.

ALPHA NU

University of New Mexico, Albuquerque, New Mexico, founded April 21, 1935.

ALPHA XI

Rhode Island State College, Kingston, Rhode Island, founded May 17, 1935.

ALPHA OMICRON

Marquette University, Milwaukee, Wisconsin, founded June 18, 1938.

ALPHA PI

University of Colorado, Boulder, Colorado, founded May 24, 1941.

*An Apology for Taxonomy**

FRED A. BARKLEY

It is my purpose to briefly review the history, to point out some of the principal phases of taxonomic work, to show why a misconception of some of the problems involved has lead to the idea of many that this field has no place in the sciences, and why it really is one of the more dynamic fields of biology that most taxonomists consider it. The constant criticism of taxonomy has caused many workers to take a fatalistic attitude toward trying to defend it, with the result that many misconceptions about systematic work have been allowed to go uncorrected. Some of these misconceptions are based on fallacies of thought which, while not being accepted by the majority of biologists, have so long been part of basic teaching that many very capable scientists have actually to make a conscious effort to cast them aside in their work.

The biological sciences may be roughly grouped into three major fields: physiology or function, morphology or structure, and taxonomy or classification. Within these, many other fields may be separated, outstanding among which are paleontology, cytology, genetics, and ecology, besides those limited to a particular group of organisms, such as anthropology, mammalogy, bacteriology, and the like. Each of these fields is made up of a great number of facets, each with its special problems, and each with problems which can be answered only to its own significant figure of accuracy. The

fields are not independent, but all inter-related; and since each is limited by the knowledge gained in the other fields, advance in one requires advance in all of the others. As generations have gone by, each has been able to refine its techniques, build on past knowledge, and pass from purely descriptive into more or less experimental phases. If one goes back two hundred years and compares knowledge in any of these fields with the knowledge of a century ago, and compares the knowledge of a century ago with that of the present, amazing progress becomes evident. And yet looking objectively at the body of knowledge of the present to some of the problems which are not solved, one cannot be other than appalled at ignorance of some basic facts. We are quite certain that chromosomes are the carriers of heredity, but there is no one who can, with anything like assurance, explain how genes exert their influence in the development of an organism so that one cell becomes ectodermal in nature, another a germ cell, with their concomitant differences superimposed on the basic cellular structure of the particular organism. We should find that great progress has been made in all fields of biology, but that we still have to determine many of the more fundamental causal relationships for which we have been groping.

We have gone rather far afield in our discussion, and since it is taxonomy which is our particular problem at the moment, let us first turn to biological history to obtain the most important

*Delivered before the Author's Club of Western Montana, December 13, 1941, at Missoula, Montana.

biological facts upon which modern taxonomy is based, and then let us dissect taxonomy and look at some of its major details.

One can only guess at the earliest knowledge of plants and animals amongst primitive cultures. Yet we know that the number used for food, protection and shelter in nomadic tribes had brought about a cognizance that several types of both plants and animals existed.

Of the hundreds of thousands of species of organisms probably only twenty thousand macroscopic ones occurred in one culture center. It is rather interesting to note that in the regions where cultures were first developed and where they flourished during the early development of western culture—in Babylonia, Egypt, Greece, Italy, Western Europe, and the Atlantic seaboard of North America—the species are rather uniformly well delimited from one another. The more important organisms of each culture center had been tested out so that by the dawn of civilization the more important ones were being used and recognized. In most cultures one finds that not only a knowledge of the surrounding life had been observed, but rather extensive lore dealing with the origin of forms had been built up.

In the dawn of civilization, man had settled down to village life and depended on agriculture for sustenance. Thus from the earliest records the organisms important to those cultures are mentioned in their writings. This does not mean that much was known of the organisms' structure and functions. Differences and likenesses of approximate rank of species were noted and similarities of types were even sometimes suggested. On the other hand animals and plants, the higher groups of each being the only ones

known in such cultures, were of course sharply set off from one another.

Early in Greek history we find extensive philosophizing about the origin of organisms. Thales declared water to be the mother from which all things arose, and Anaximander vaguely outlined the idea of transformation of aquatic species into terrestrial. Xenophanes is credited as being the first to recognize fossils as the remains of animals once alive, and to see in them proof that once the seas covered the entire surface of the earth.

Aristotle, with the forms sent back from the expeditions of Alexander, was probably one of the first to have any fair conception of the geographic differences in the composition of the fauna and flora, as well as having the greatest variety of organisms assembled together up to his time for study. He attributed all evolutionary changes to natural causes, conceiving the forms of life as having arisen from a primordial soft mass of living matter, with a linear phylogenetic series, beginning with plants, then plant animals (as sponges and sea anemones), then animals with sensibility, grading up to man. In his treatises he collected all contemporary knowledge of animal life as well as the material he could obtain regarding the observations of the earlier philosophers and made essentially important contributions to the subject of animal classification by analyzing and characterizing a number of systematic categories, separating them according to their way of living, their actions, their habits, and their bodily parts.

Theophrastus, the friend and follower of Aristotle, is the author of two treatises on plants, in which a large number of plants (mostly of economic importance) are rather well described, but in which plants are grouped as trees, shrubs, and herbs. Dioscorides,

who probably lived at the beginning of the Christian era, wrote a pharmacological account of plants which was very celebrated.

Pliny, among his many activities, compiled a Natural History in thirty-seven books, which dealt extensively with plants and animals. In the zoological section various animals are enumerated, usually with the largest and most remarkable treated first, and described as to their habits, utility or mischief they do, first appearance and internal structure. His account of plants is taken almost entirely from Theophrastus and Dioscorides. Here we find one of the first attempts to embrace all known organisms into one work, an attempt which a careful scrutiny of biological history will show has been paralleled time after time.

We may sum up the advances of the classical period in the field of biology as having been made in the description of common organisms, principally the seed plants, vertebrates, corals and sea anemones, descriptions limited in most cases to the gross external characters for their recognition, although a few of the more obvious internal organs of animals had been examined. A little knowledge of the local abundance or distribution of organisms had been gained, and a few gropings after the explanation of the different forms of life had been made.

In the fourteen centuries following Pliny's work, if the description of a few organisms by the Arabian natural-

ists be disregarded, the status of biological knowledge can be said to have changed very little.¹

The renaissance of science and the revolt against classical authority was gradual. The great intellectual advances made by Roger Bacon, Cusanus, Copernicus, Bruno, Francis Bacon, and Galileo, paved the way for advances in all fields of science.

In botany Brunfels made a start away from classical authority by adding his own observations to that of classical writers in his *Herbarium vivae eicones*. Bock and Fuchs in the sixteenth century continued this revolt, the latter's beautifully and profusely illustrated *Stirpium* being almost entirely an account of its author's observations. The beginning of this break from classical authority in zoology is usually attributed to Conrad Gesner who wrote an immense four-volume encyclopedia on animals, *Historia animalium*, which, while of the general type of Pliny, has the author's own observations. He was probably the first to illustrate his zoological writings.

During this period fundamental contributions to anatomy made important advances, which in time became the basis for advances in classification. Some of the outstanding of these were the publication of Vesalius' excellently illustrated observations of his many careful autopsies, Fabrezio's application of comparative methods in the study of anatomy and embryology, and Harvey's demonstration of the function of the heart.

Caesalpino made an advance toward a more natural grouping of plants in that the old grouping of trees, shrubs, half shrubs, and herbs was replaced by a system based on kinds of fruits.

In the seventeenth century, the basis of paleontology was laid when Steno

¹The later theologians had put a quietus on all speculation as to the origin of forms, which was in opposition to the idea that all species had arisen as a special creation. A vogue for blind adherence to the teachings of the classical writers prevented writers from making any attempts to observe nature about them, so that they followed the master's works without question. The failure to realize that the organisms of western Europe differed from those of the eastern Mediterranean region led to some very absurd conclusions as to the identity of forms.

concluded that the geological strata in the area of Tuscony, where he was studying, had been stratified out of water and confirmed his conclusion by pointing out the plant and animal fossils that they contained.

Malpighi with a genius for microscopical technology, made the real start toward anatomical study of animals, and is given credit, with his contemporary Grew, who worked independently, for the founding of plant anatomy.

The systematical terms which had been used by Plato, *eidos* or species and *genos* or family had been continued down through the ages.²

Caspar Bauhin while not advocating reform in various lines actually improved the taxonomic treatment of plants in that he seems to have grasped relationship of forms and arranged the plants he treated in a manner to indicate those he considered primitive (the grasses) on to those most advanced (the trees). He never characterized genera but treated the species of a genus together. He also often replaced cumbersome polynomials with binomials.

Following Bauhin were a great array of plant systematists. Tournefort who based his classification on the flowers and fruits of plants, and genera, for which he seems to have had a genius for segregating, were given excellent characterizations so that his concept of genus is essentially that of the present.

Redi proved that worms in rotting meat are not in consequence of putrefaction but as a result of eggs laid by flies on the meat, thereby challenging

the widely accepted theory of spontaneous generation of life.

Camerarius proved sexuality in plants.

The discovery of the cell by Robert Hooke paved the way for the development of cytology and histology.

During the seventeenth century little advance was made on systematic zoology. Ray made several advances in the field of systematic botany and zoology. He clearly realized the differences between genus and species, and he sensed the similarities on which affinity in its wider sense may be based, so that while many of his divisions are artificial, many of his groups in both the plant and animal kingdom are properly "natural."

The eighteenth century saw the first uniform concept of life-form—that of the Swedish biologist, Linnaeus, the founder of modern plant and animal classification. Linnaeus was a man of great personal magnetism; his wide travelling in Europe not only brought him into contact with the many new types of plants and animals which were being brought back to Europe during that period of exploration, but gained for him the admiration and respect of most of the outstanding European biologists of that time. In his work he adopted the theory of species as being created from the beginning and immutable, thus ruling out both spontaneous generation and evolution. His publications in natural history were many. His greatest improvement in taxonomy was effected in binary nomenclature which he applied to all plants and animals. The work of describing new plants and animals was enormous; yet he made major contributions in the theoretical problems of classification. He settled on a plan for the classification of plants, using the reproductive parts as the basis for sep-

²Comparatively simple terms have been applied to organisms in classical antiquity much as common names are now applied. As forms similar to known forms were found, an additional descriptive word or phrase was added to the name of the earlier form, and applied to the later form, this continued until the name of an organism often was a series of ten or fifteen words, and often through a lack of knowledge the same form had received several such sets of names.

aration.³ While very artificial, this system marks a great advance over any previous attempt at classification of plants.⁴

Cuvier's classic studies of anatomy founded the modern field of comparative anatomy. With his friend Brogniart he made systematic excavations for fossils and was able to reconstruct the missing hard parts and then the soft parts, thus creating modern paleontology. By introducing fossil animals he reformed the system of zoological classification. Cuvier was a strict adherent to the idea of special creation. The occurrence of fossil forms unlike living ones was explained by the widely accepted idea that major geologic catastrophies had caused world-wide destruction of living forms and were followed by new creations.

This idea of catastrophism was strongly opposed by Hutton, who advocated the doctrine of uniformitarianism, that past changes on the earth are the result of the gradual changes, such as erosion, which are occurring now, with volcanic outbursts, earthquakes, and floods of only local importance. This idea became generally accepted after its successful defense by Charles Lyell.

³His system is essentially a key to the forms, and has paved the way to the construction of those keys for the determination of organisms, which are now essential in taxonomic work. The twenty-four classes of plants which Linnaeus recognized were founded upon something concerning the reproductive parts of the flowers; the first great division was into two great series, the Phanerogams or seed-producing plants and the cryptogams or those with hidden sex. The Phanerogams were then divided according to the presence of the stamens in the same flower with the pistils, and according to whether the stamens in a flower were of the same length or not, and to the number of stamens.

⁴His classification divided animals into six classes: Quadrupedia, Aves, Amphibia, Pisces, Insecta, and Vermes, largely on external characters, and can hardly be said to rank equal to the previous work of Ray. The three classes, Cryptogamia, Insecta, and Vermes, include the great majority of species of organisms as we know them today.

The nineteenth century saw a really rapid change in scientific ideas.

Von Mohl showed that new cells arose in plants by a partition forming in an old cell. Robert Brown in 1831 published the discovery that in the contents of every cell there belongs an areola or nucleus. Finally, Schleiden and Schwann formulated the theory that all living organisms are composed of a community of cells.

The generally accepted theory of spontaneous generation was not completely disproved until the conclusive work of Louis Pasteur on microorganisms.

Richard Owen, a great comparative anatomist, is given credit for the origination of the terms *analogy* and *homology*.⁵

While it was known that there was an alternation between individual organisms and colonial organisms in some groups, it was Steenstrup who took a number of forms of invertebrates and showed that in each, a generation which reproduced asexually gave rise to a generation which reproduced sexually, and this in turn reproduced the asexual type. Through this knowledge of alternation of generations von Siebold was able to describe the life-history of some intestinal worms, both as to their alternate hosts and different forms. Siebold and Ehrenberg brought about a correct understanding of the structures of the organisms now generally known as Protozoa, although

⁵Owen meant by analogy a part or organ in one animal which has the same function as another part or organ in a different animal, and by homology the same organ in different animals under every variety of form and function. He mentions three distinct types of homologies: special homology or agreement between a part or an organ and a part or an organ in another animal; general homology or the relation between an organ or a series of organs and the general type in conformity with which the animal is constructed; and serial metameric homology or the repetition of certain organs in the same individual, segment by segment.

they found difficulty in excluding certain green unicells.

In the field of systematic invertebrate zoology Leuckart made significant advance in his publication of five fundamental types: Coelenterata, Echinodermata, Vermes, Arthropoda, and Mollusca. Though sundry modifications have taken place since that time, they are still widely accepted. With the explanation of the division of labor within certain colony-building forms in which individuals are converted to perform special functions necessary for the welfare of the whole community, fresh light was thrown on the biological meaning of the term "individual."

Reform in botanical classification was rapid in this period; de Jussieu worked out a classification in which he attempted to show the relationships of the plants by their arrangement in a natural system built up in determined opposition to the artificial system which Linnaeus' sexual system was.

Augustin Pyrame de Candolle, the first in a dynasty of botanical scholars adopted Cuvier's correlation theory to the plant kingdom.⁶

Plant classification received further impetus through Endlicher, whose service lies in his particularly clear, concise, and complete characterization and demarcation of families and genera which made his work the basis for all later plant classification.

The specialized study of particular botanical groups also became the vogue in this period, and the lower plant groups which had been neglected for the most part began to receive more careful study.

⁶DeCandolle started a gigantic work, *Prodromus systematis naturalis regni vegetabilis*, which was to describe all known plants. While his work on plant morphology and physiology was of great importance, he is interesting to us for his contributions to taxonomy. He established the difference between vascular and cellular plants and his classification of the dicotyledons has been largely accepted by subsequent botanists.

Hedwig studied the multiplication of cryptogams, making careful observations of the propagation and germination of spores.⁷

The pioneers of alga research were Carl Adolf Agardh and his son Jacob Georg.

The basis of classification of the fungi and the description of species, genera, and families of fungi which are still largely followed were produced by Elias Fries.

A century after the death of Linnaeus in 1778, many contributions had been made in many fields of biology: life histories, invertebrate morphology, cryptogamic botany, more natural systems of classification. Yet these changes had brought almost no change in the philosophical background of classification. One of the foremost systematists of the period was Asa Gray, who worked at the time when exploration of the West was under way, and who is still looked to as a master of lucid botanical writing and clear demarcation of species and genera. He says:*

⁷Hedwig is chiefly noted as a pioneer in the study of mosses, for he divided the large and unwieldy Linnaean genera into a number of well characterized ones.

*"Plants and animals, as is well known, have two great peculiarities . . . they form themselves; and . . . they multiply themselves. They reproduce themselves in a continued succession of individuals . . . Each owes its existence to a parent, and produces similar individuals in its turn . . . All the descendants from the same stock therefore compose one species . . . So we are led to conclude that the Creator established a definite number of species at the beginning, which have continued by propagation, each after its kind . . . there is the resemblances of kind we take for granted have not originated from one and the same stock but from . . . separate stock. Nor do we deny it on account of every difference; for even the sheep of the same flock . . . may show differences and such differences occasionally get to be very striking. When . . . well marked, we call them varieties. The question often arises, practically, and it is often hard to answer whether the difference in a particular case is that of a variety, or is specific . . . If the former, we may commonly prove it to be so by finding such intermediate degrees of difference in various individuals as to show that no clear

I have quoted Dr. Gray's discussion of classification at length, because it clearly outlines the problems of classification in his day very concisely. If this were the real status of classification today, we should not be annoyed by much of the misunderstanding and criticism of taxonomy which comes from an unfortunate lack of realization by many that we are not working with the same set of rules. In a footnote⁸ Dr. Gray continues his discussion of classifications, and what he says (if one were to take out the references to species creation) applies at the present time.

Let us review the situation of taxonomic knowledge and theory just be-

line of distinction can be drawn between them; or else by observing the variety to vary back again, if not in the same individual, yet in the offspring . . . If the species, when arranged according to their resemblances were found to differ from one another about equally . . . then, with all the diversity in the vegetable kingdom there is now, there would yet be no foundation in nature for grouping species into kinds, species and kinds would mean just the same thing . . . The fact is, however, that species resemble each other in very unequal degrees. Some species are almost exactly alike in their whole structure, and differ only in the shape or proportion of their parts, these, we say belong to one genus. Some, again, show a more general resemblance, and are found to have their flowers and seeds constructed on the same particular plan, but with important differences in the details; these belong to the same Order or Family. Then, taking a wider survey, we perceive that they all group themselves under a few general types (or patterns), distinguishable at once by their flowers, by their seeds or embryos, by their character of the seedling plant, but the structure of their stems and leaves, and by their general appearance: these great groups we call Classes . . . The System of Botany consists of the orders or families, duly arranged under their classes, and having the tribes, the genera, and the species arranged in them according to their relationships. This, when properly carried out, is the Natural System; . . . now this word plan of course presupposes a planner,—an intelligent mind working according to a system; it is this system, therefore, which the botanist is endeavoring as far as he can to exhibit in a classification. In it we humbly attempt to learn something of the plan of the Creator in this department of Nature . . . So there can be only one natural system of botany . . . but there may be many natural systems, if we mean the attempts of men to interpret and express the plan."

fore the middle of the nineteenth century. New species which had turned up from the various parts of the world had been described by the thousands. Not only the higher plants and animals were being described, but the more inconspicuous lower forms had received considerable study. Many fossil forms had been discovered and described. The idea of uniformitarianism had become established in geology. The external form was no longer the only matter of interest, but careful microscopic anatomical studies on organisms had been made. Comparative anatomy, embryology, and life studies were described. The structure of one-celled organisms was rather well known. Organisms, still grouped as from classical times into plants and animals, were in general divided into seed plants and cryptogams, and vertebrates and invertebrates. The idea of a natural system was recognized as a possibility and was being groped after. Fixity of species from a divine creation was accepted. It was inferred from this that any difference found in nature, if hereditary, constituted a different species. At that time the outstanding duty of a systematist was to catalog all of the species and then fit them into the mosaic of the natural system. Practical difficulties constantly arose when this was attempted.

Two bombshells, however, were ready to explode in this complacent state of

⁸"The best classification must fail to give more than an imperfect and considerably distorted reflection, not merely of the plan of creation, but even of our knowledge of it. It is often obliged to make arbitrary divisions where Nature shows only transitions, and to consider genera, etc., as equal units, or groups of equally related species, while in fact they may be very unequal,—to assume, on paper at least, a strictly definite limitation of genera, of tribes, and of orders, although observation shows so much blending here and there of natural groups, sufficiently distinct on the whole, as to warrant us in assuming the likelihood that the Creator's plan is one of gradation, not of definite limitation, except as to the species themselves."

biology, the first Darwin's and the second Mendel's.

The idea of evolution, as we have seen, was vaguely envisioned by the Greeks, and had in the eighteenth century been advocated by Buffon, Erasmus, Darwin, Lamarck, and St. Hilaire only to be discredited by the hold of the later theologians on the most influential biologists of that period, so that it had no important part in the philosophy of the time. But Charles Darwin after his voyage on the *Beagle*, settled himself to working over his observations and with the stimulus of various writers spent years accumulating data which he published in 1859 in his *Origin Of The Species* which most forcefully set up the case for the doctrine of evolution. After Thomas Huxley, an important investigator in the fields of comparative anatomy and embryology, had ably defended the theory of evolution, it was on such a firm foundation that all attempts to discredit it have failed.⁹

The second major influence on taxonomic thought was the discovery of the basic facts concerning heredity.

Weismann propounded the theory of the germinal continuity of organisms from generation to generation. The results of Gregor Mendel's technique showed that a series of unit characters persist (even those overlain and obscured by dominant characters) and are capable of segregating themselves out undiluted in a series of generations.

These principles vastly changed the philosophical background on which taxonomy is built, particularly as regards the nature of species and other

taxonomic categories; they also gave more depth to the idea of a truly natural system.

The modern era has seen a banding together of botanists and zoologists to prepare Rules or Codes of Nomenclature so that a uniform system of names will be maintained. These rules specify how new names shall be formed and how, when several names have been applied to one form, the proper one shall be selected. The binomial system for species, introduced by Linnaeus, is the basis for this.¹⁰

The matter of unequal dimensions of taxonomic groups means that the delimitation of categorical groups must be left to the individual biologist. What the international rules intentionally do not say is what shall constitute a particular category. The fact that taxonomists do not always see eye to eye has brought forth a major criticism of taxonomic work; yet a review of the advance in classification the last century shows that progress requires a free rein for increasing knowledge to guide the way.

If our major premise of evolution is correct the ancestors of living organisms had ancestors, and these in turn had descended from the original form of life.

Thus, if one were to consider all life, past and present, any separation into categories would be arbitrary, artificial, and decided by convenience at such points as transitions to related groups

⁹This of course does not mean that the Darwinian theory of evolution is still adhered to, but that the general concept of unity of organisms through evolution is now accepted as a basic biological principle. An intimate study of evolution is one of the most technical of all the fields of biology (cf. Dobzanski, and Hiesey, Clausen & Keck).

¹⁰The various grades or categories which are recognized for plants and animals have grown considerably from those in use a century ago, and vary somewhat between botany and zoology. If these were combined for both botany and zoology (and they have to be combined when one is working with both plants and animals) the common categorical grades would be included in the following series: Kingdom, Division, Phylum, Class, Order, Family, Tribe, Genus, Section, Species, Variety, and Form. (Convenience often requires "sub-" and "super-" grades for the various categories.)

occur. A convenient method in description or delimitation often relied on is to assign the limits to a group where a breach in knowledge, usually termed a "missing link," occurs. As pointed out by Schaffner, Copeland, and others, another point of convenience is that phyla and classes be not too numerous, while orders, families, and genera should not be too extensive. A third matter of convenience and practicability lies in the fact that conservatism requires the retention of a familiar category until a new one shows greater conformity to relationship. The rate of evolution in different groups and the direction of evolution differ markedly; otherwise some groups of organisms would not retain their great complexity. Thus since groups of organisms, regardless of the category involved, have all started their particular special evolution from the parent stock at different times, each evolved at a different rate, and each in different respect, when viewed at one particular time (as for instance in the twentieth century), the obvious conclusion is that no two groups assigned to the same category are actually of equal rank. Then it is not surprising to find two genera of the same tribe, one of which has widespread well differentiated and clearcut species and the other with species of limited distribution and poorly differentiated from one another, or one genus where evolution has been largely in the modification of the leaf while another may show modifications in stem, or inflorescence, or fruit.

The happy union of showing accurately the phylogeny of organisms and at the same time being practical in use is one test on which any system of classification either stands or falls. No matter how close to theoretical perfection a system comes, if it is too cumbersome to be used, it will not be of great value. On the other hand, the person

clamoring for a practical system usually forgets the limitations of the material under consideration, the fact that there are no hard and fast delimitations to be made between most groups and that the groups themselves are not of equal dimensions but those of only approximate likeness are being squeezed into equal sized categories.¹¹

It is time to point out that while any systematist will refuse to say that he does not know what a species is and he can point out any number from his surroundings, a really comprehensive definition of a species has never been achieved—for after all a species is only a *concept* which we fold around a group of individuals and thereby indicate their close affinity.

This statement about the species applies to all of the categories. Since these categories are not God-given rankings (and the idea of special creation with its equal categorical rankings of like dimensions, while long technically replaced has not been actually replaced so far as many biologists and laymen are concerned,) it is to be expected that taxonomists are going to assign various forms to different groups. Their ideas of phyla, classes, and orders vary somewhat so that their resulting treatments eventually shine forth with the final result that a more logical and practical system is evolved.

Let us consider some of the modern concepts of a natural system of classification.

Our modern concept of the relationship of organisms in the natural system is not a linear series such as must be

¹¹A false assumption fallen into by even many biologists is that we are sorting cards of equal size into pigeon holes arbitrarily selected as of convenient size. But although the cards may be of approximately similar size, some are small enough to fall out easily and others must be bent to be put in.

followed by the limitations of writing, but is more or less a polka-dot mosaic.¹²

A more detailed study of the simpler forms of both plants and animals leads to a realization that the difference between plants and animals was not so great as had been long supposed. When the study of flagellated algae (or if you choose, the green protozoa) was begun, only an arbitrary separation could be made and it became apparent that the two groups were not natural ones. As early as 1866 Haeckel had proposed the separation of the intermediate forms into a third kingdom, the Protista, a proposal that could not withstand the pressure of long tradition, separating organisms into but two kingdoms.

Zimmerman in 1930 plead a very convincing case for the separation of all living organisms into those not bearing a nucleus in the cell¹³ and those with nucleated cells, since this, the most fundamental difference to be

found, is of far greater significance than any difference between animal and plant forms. In 1938 Herbert Copeland followed that viewpoint and separated the Schizophyta¹⁴ as the Kingdom Monera, a treatment that, from the standpoint of convenience and logic, should gain universal acceptance in the future. At the same time he advocated the resurrection of Haeckel's Kingdom Protista to include the algae (exclusive of the green algae), the protozoa, the fungi, and the slime molds. The separation of the Protista from Animalia and Planta is not built on such a strong basis as the separation of the Monera; yet from the viewpoint of both pedagogy and taxonomic convenience it would be a valuable departure, since the phyla contained in the proposed kingdom can be separated with fair precision. Under the old two-kingdom system the phylogenetic picture is distorted; since some phyla have organisms which are commonly adjudged to be more plant-like than animal-like. So we can expect the acceptance of the four kingdom system after the long period of disapproval that greets any change from familiar ideas.

The species of northeastern United States are on the whole rather uniform and widely distributed. Since the preparation of a flora of that region therefore consisted largely of listing and describing the obviously different species found there and did not present the difficulties which have been encountered in other regions, the keen observation and unequalled clarity of writing which Gray produced stands as a classic of floristic excellence.¹⁵

¹²However, when these relationships are traced back through the ancestry gathered from comparative studies and the fossil records, they present a dendroid arrangement, with the polka-dots being the ends of the branches cut through by our present time. Even this dendroid outline, which has been assuming more and more definite form as further knowledge has accumulated, shows major gaps in places and certainly the attachment of many of the branches can now only be guessed at. On the other hand, in many cases enough supporting evidence has accumulated so that the insertion of the branches can be hypothecated with a considerable degree of confidence. In other cases without too much credulence major branches may be hypothecated from good logic, as for instance a gastrula phylum amongst animals, postulated from the occurrence of a gastrula in the development of numerous forms in many of the animal phyla. Likewise we may assume more primitive forms than any known, leading back to the earliest living organism, which with good logic we can assume was composed of protoplasm and had the ability to reproduce.

¹³From the basis of logic it seems to the author that the sponges (Porifera) would also have to be included there since their phylogenetic origin seems to be different from that of the Coelenterates and higher animals. From a similar reasoning the green algae could be treated there with equal facility and with far more convenience.

¹⁴The recent work of Robinow, Lewis, and others on the nucleoid bodies of Schizophytes hardly invalidates this distinction.

¹⁵Yet even there some groups presented problems. A natural delimitation of the species of such genera as the red haw (*Crataegus*), rose (*Rosa*), and willow (*Salix*) with their extreme variation between in-

The species problem encountered in other areas is much more difficult. In the tropics, while some species are very widespread, often a group has many species, each with an unbelievably narrow range. The situation in the western part of the United States has presented other problems. During the exploration of the West many collections were sent back to eastern biologists. Since these usually represented samples from widely separated areas, the individuals of a single genus were usually quite different from each other and the known species of the genus. To a person working on the assumption that all species were created as such, the task was easy, merely being one of tagging each specimen with a name and writing a description of it. However, as more and more specimens from more and more areas filtered back, the situation appeared in a different light. In many cases adequate collections showed that the differentiates which had been catalogued as separate species were merely local variants, all the intergradations being present. With the theory of special creation the cataloguing was a real problem, and while the doctrine of evolution answered the question of why, it did not reduce the discomfort of the systematist, for there was the practical necessity of treating these intergrading types taxonomically. Where differences occurred in a particular region of the entire distribution, custom often dictated that the variant be called a variety (botany) or subspecies (zoology); the school of biologists who designated each variant as a species has essentially disappeared.

dividuals has defied solution. Other cases which on the surface appeared to be clearcut have proved, on genetical and cytological grounds, to be much more complex—most of the kinds of the evening primrose (*Oenothera*), which when reviewed appear as clearcut units, have been shown to be hybrid groups, which, because of balanced lethals, can occur normally only in the hybrid form.

Where the well-marked variant was set off with no intermediates or a geographic gap between the variants, the specific status could be assumed with assurance. Where the variants were not well marked but were set off with a geographic barrier, and where the variants were very well marked but some intermediates were known, the question of status was one which caused a great deal of difficulty. Should the specimen be called a species, a subspecies, or a variety? There population studies, genetics, and cytology or even certain types of ecological studies can often come in to settle the question of whether the intermediates the product of their respective environments, are present as remnants of divergent evolution, or are present as hybrids between well differentiated species whose ranges have converged. Each species and each genus, then, requires particular study. Unfortunately the viewpoints of taxonomists differ somewhat; therefore anyone who is accustomed to the field at all realizes this and is not dismayed at the difference in treatment. That elusive criterion, good usage, is the measuring stick which all taxonomic treatments are eventually judged by.

Then let us consider another field of criticism, the comparative value of monographic studies and faunistic and floristic studies. Faunas and floras are based on extensive field study and collection, and usually cover the animals or plants of a limited area.¹⁶ On the other hand, at first glance the immense collections in institutions seem absurd; people spend their lives preparing, sorting, and saving collections of organisms which seem to go unused for

¹⁶They are the immensely practical works used by the people of the area. They usually answer questions about the variation among the forms growing in different situations or habitats and about the local distribution of forms, and they present practical keys to those forms for that area.

years. Yet eventually from decades of such work, enough specimens are accumulated so that a monographer may study each group minutely to see the variations and the geographical distribution of the variants; so he may undertake the extensive and intricate work of nomenclature in the group. These monographs are then available for the preparation of faunas and floras.¹⁷ Many weaknesses in the previous system have become apparent, and techniques in classification have greatly improved.

Equal change will be noted in zoological knowledge by reference to some of the recent texts, notably Hymen.

These rapid changes in knowledge and method require a shifting emphasis in the parts of a system of classification. The practical botanist wanting a static system criticises this shifting; on the other hand, he is often criticised because he does not use the latest and newest. However, no criticism can justly be levelled at the biologist who uses an old and established system when, for the purposes of his work, it is adequate. For instance, in an herbarium where frequent rearrangement is an insuperable task and where a vast body of reference material in indexing is necessary, the use of such a system as that laid down in Engler and Prantl's *Die Natürlichen Pflanzenfamilien* and De Dalla Torre and Harm's *Genera Siphonogamorum*, is hardly to be criticised. However, the professional taxonomist who used the Englerian system to arrange his herbarium, should he at this period use the same system as a basis for his

thinking, would hardly come in for hearty commendation.¹⁸

Another similar point of criticism comes from a distortion of classification as presented in many of our modern elementary texts. Conservatism in the presentation of new material on classification in such texts until it has been tried out is not to be criticised. Nor is it necessary to present all of the known forms of organism. However, no justification can be seen for carrying the simplification process to the extent of using a classification long shown to be inadequate, or the use of incorrect categorical terminology,¹⁹ or the inclusion of decidedly unrelated organisms in one group to obviate mention of two groups. Omitting mention of unimportant phyla is permissible. But when an organism from a phylum not mentioned is discussed, it is much better to say it belongs to a phylum not otherwise discussed than to place it in some widely separated phylum.

The presentation of any classification as final in any course is unpardonable; all systems which one can now envision being proposed in the present century will of necessity need revision in the light of new knowledge. Therefore the elementary textbook writer is confronted with the task of presenting taxonomy (1) so that the system employed is logical and adequately contrasts the various organisms, (2) so that the system, simplified for elementary use, does not distort relationships, (3) so that the system is pre-

¹⁸For the experienced taxonomist to step from one system to another in his thinking is about as difficult as taking any of the half dozen streets that lead home from work, so that a systematist's flights from one system to another between his practical work and his theoretical work is a surprise to the uninitiated who is often left in a hopeless maze.

¹⁹For instance, the use of the term *phylum* applied to the Thallophyta, a group which in one's wildest imagination could not be justifiably coordinated with the animal phyla, where the categorical term has long been stabilized.

¹⁷If all the groundwork covered in monographic works had to be done by anyone preparing a fauna or flora, the task, in this period where detailed basic work is necessary, would be so great that few would make the attempt.

sented as a tentative one which will be modified when and as more knowledge is accumulated, and (4) so that the concept of each category is one accumulated, with the limitations imposed on it by the evolution of forms. But wherever the processes of conservatism and simplification are carried to such an extent that the material learned in an elementary course must be unlearned at the beginning of advanced work (as is the case with many of our "modern" textbooks), wholehearted condemnation is deserved.

In summary, then what are some of the outstanding fields of endeavor for the taxonomist?

Through monographic works he must build up the knowledge of limited groups, delimiting the varieties, species, genera, and even families so that they are of practical significance and at the same time show the relationships so far as possible. Through floristic and faunistic works, correlate the monographic studies with intimate field studies, and make them available to the applied systematist. The construction of a natural system of classification which will be practical and which will depict the natural relationships of forms is the final assignment. It remains for many fields of biology and for the cooperation of biologists, to furnish the knowledge hidden in cytology, embryology, genetics, morphology, ecology, and paleontology. Only

through such knowledge may an approach to these ultimate goals be made.

The inherent complexities involved in controlling all the factors affecting an organism in a physiological experiment as well as the complexities of the physics and chemistry concerned have prevented the physiologist from giving answers with a limited significant error. It is true that the error has decreased as a body of knowledge about the controlling factors has increased; yet the limiting factors are so well understood that the findings in physiology are greeted as being phenomenal. The factors controlling morphological development are so complex and so diverse in the various groups that development in these lines has been limited. If taxonomy were merely the cataloging of different forms with equal sets of divergences, a legitimate criticism could be levelled at the taxonomist that all of the known forms have not been catalogued in a permanent system; but nature did not hand out any such simple task.

So in conclusion, the apology which I would make for taxonomy is not that its methods are faulty or that it has not progressed as it should, but that its workers have failed to clarify the situation under which they are working so that the criticism of vacillation and lack of clarity that is levelled at the field comes from a misinterpretation of the inherent complex nature of the materials with which they are working.



Keefe in Australia

Dr. Keefe is now with our armed forces in New Guinea. The following is a copy of two V-mail letters received from him while he was still in Australia. His remarks concerning the animals and plants will be of interest to members of Phi Sigma.

My Dear Art:

Your letter of June 11th finally caught up with me when I was out in the "bush" of Australia. That is so very vague and indefinite that I'm sure the censors will let it get by. Sometimes it is known as the "Outback." That is anything out and beyond the coastal fringe of more or less inhabited country. More than two-thirds of Australia is "Outback" but not all of it is "bush." ("Bush" is from the Holland "Beach," meaning scrub timber country.) We were there from early June to late September. Now back in a rest camp for a little while.

During this time I've put 13,000 miles on my "Jeep," first of all going overland more than 2,000 miles to our destination and then making a weekly trip to and fro between our hospitals 300 miles apart. Later other chaplains came in to help, so I settled down a bit for a short month and then, our services being no longer needed, we were moved to this present temporary location.

All of this is by way of prelude to letting you know that I've had the chance of a lifetime to get some first-hand acquaintance with a fauna and flora so different from anything our home biologists ever see, or hope to see. My only regret is that all my impressions are mental, and I won't have a plant or preserved animal specimen to bring back with me.

At that I would not have missed it for worlds. Some one has said that Australia is where Evolution stopped before it got half through. To the truth of which as a teaching biologist I can heartily assent. I haven't seen any of the three-foot earthworms, but there has been much I have seen that in more senses of the word than one have reminded me much of the author of "The Vegetable Mould and the Earthworm."

Eucalypti are the commonest trees down here and go by the ever present name of "gums." Right now the White Bloodwoods and the Plunkett Mallees, (*E. trachyphloia* and *curtisii*) are all abloom—it's early summer here, you know, and from the hilltops the forest roof looks like billowing waves of frothy white—rather difficult to describe as we have nothing at home to compare with it—except perhaps an apple orchard seen from above, but then the Bloodwoods are from 50 to 150 feet tall, so the comparison rather bogs down.

This flowering season brings out the birds in force. Three are most common, a honey-sucker, between the size of our wrens and sparrows with a curved bill, gray breast, and gray-green back and wings. Had an injured one to look at the other day. Very unfrightened, as are most of these Australian forms, sometimes almost impertinent. With them are the leatherheads and the parrot family. Leatherheads are about the size of our pigeons, with feather-less heads and horn-like top ridge, all coal black—rest of the bird gray-green above, gray below. (Noisy, quarrelsome, and an ugly call that sounds all day and half the night, "Tek-a-



look!") Parrots vary in color, mostly greens with red shoulders, to small green parakeets which come in mobs and when they get together make a noise which some one rather aptly characterized by calling them "jangle birds."

They are busy all day long in the bloodwood flowers, and the sour-pussed Briton who said "Australia is a land where the flowers have no scent, and the birds no song," set himself down as the greatest liar since Annanias. Why even the Kookaburra (laughing jackass to you) is a pleasant bird, and considerably more than a droll fellow. They tame readily and are the most whimsical pets imaginable. At one of our stations there was an old hotel taken over as a residence for the staff of the local area. I had a friend there, a chaplain from Illinois. He wasn't much of a naturalist, so he was pretty much put out by the antics of a Kookaburra which had adopted the staff. Used to fly down and perch on Chaplain Wales' shoulder as he shaved. Whether the bird was entranced by looking at himself in the mirror too, or just did it

because it annoyed the chaplain is hard to say. Said Kookaburra one day as we sat chatting, suddenly flew up onto the wall (open to the ceiling) of Wales' room and sat there preening himself, altho very bedraggled. I asked what was wrong with the bird. "Oh, he's probably just had a bath in one of the officer's water buckets." Kookaburras belong to the Kingfisher family, but they are very much of a land form, found all over the continent.

But you are more interested in the reptiles, I suppose, as a good herpetologist. There are four very venomous snakes here, of which I've seen only three isolated specimens, the Death Adder, the Black and Brown snake. All of which goes to substantiate the claim that there are not very many kinds of venomous snakes and even these are not plentiful or common.

The Black and Brown snakes are nothing unusual, being, as far as I know, fanged like our rattlers but with four instead of two movable fangs. The death adder is as unprepossessing as his name indicates. He is a short, stubby, broadbeamed cuss, tawny in

Father Keefe was the first editor of THE BIOLOGIST. He resigned from his editorial duties when he was recalled by the army. Father Keefe's official title is Lieutenant Colonel. He was born at Oconto, Wisconsin. "His scholastic record which was culminated with his work as a former Rector and Dean of St. Norbert College, West De Pere, Wisconsin, is a long list of achievements." His primary duty in the Army is as a chaplain. The following is taken from the Bull Sheet, published by the 135th Medical "Bull Regiment," August 1, 1941. "Father Keefe was appointed a Chaplain (Captain) in the Officers Reserve Corps on the 10th of January, 1924.

In 1937, Chaplain Keefe was appointed a Major in the Reserve Corps. His appointment as Chaplain (Major) in the Wisconsin National Guard was made in February of 1939, and he was associated with the 135th Medical Regiment. His latest step along the road of advancement was made on the 30th of July, 1941, when he received official notification that he had been appointed a Lieutenant Colonel. His promotion will be acclaimed not only by the men of the 135th Medical Regiment, who know and respect him so well, but by all those even remotely connected with his work."

I am sure that all of the delegates and officers at the National Meetings in Dallas, Texas were glad of the opportunity to fraternize with Father Keefe; and every member of Phi Sigma wishes him the best of luck with his work in the army.

color with some yellowish bands passing from dorsal to ventral at an angle to his main length. Habitually flattens himself like our hog-nose, and has a curious waxy appendage at his rear end, or tail-tip, which is more or less motile. It looks not unlike the rear end of a fat grub. Sir snake wriggles himself into an almost circular position in the sand or dust with his head not far from the tail-tip. (He's stone deaf, they say, and should be called a "deaf adder.") Then when an incautious animal, especially a bird, comes along, he wriggles the yellow tail-tip which is projecting upwards at right angles to his body, or perpendicular to the soil. The minute the bird makes a go for his tail its doom is sealed.

Among other reptilian forms, and most curious, are the great number of lizards. There is a horned toad which makes our desert form look like a piker. Sand yellow with chocolate markings and as spiny as a sea urchin. The lizards proper are many. Very long and graceful, a lot are like ours, but

the "frillies" with their expansible collars, and the "goannas" with their tyrannosaurian heads are the most notable. There is another, unscaley, with a body of shiny plate, thick-tailed, from 1 to 2 feet long, and he is a beauty. Has a steel-blue belly, shiny black sides striped with lemon, and a distinctly crotaline head, with over-arching eye-folds that make him look very prehistoric and sinister. He can go to beat blazes using his forelegs to drag himself along, with only an occasional push from the rear appendages. (Only when getting over obstacles, otherwise his rear end travels most sinuously and snake-like.) His tongue is used like a snake's but does not seem to be forked, rather it is broad, (as your thumb) blunt ended and of a beautiful corn-flower or chicory blue. Hence his name, "Blue Tongue."

Best wishes to all the family for a very Merry Christmas and a Happier New Year.

FATHER KEEFE.



Book Reviews

Except for the signed reviews, the thumbnail sketches of current biological literature appearing in this section are not meant to be exhaustive or deeply critical. They aim to survey the rapidly growing field of biology. Naturally these reviews represent the candid opinions of various readers not necessarily those of the National Council, nor even those of the Editor.

PROBLEMS OF AGEING by E. V. COWDRY, Editor. *The Williams & Wilkins Company, Baltimore, Md. 2nd Edition. Revised. Enlarged. Price \$10.00.*

Each chapter in this book dealing with the ageing of plants and various organs of animals has been written by a specialist in his particular field. This has brought many points of view together from the experience of these contributors. In many instances the collaborators have reported experimental and clinical findings resulting from their own investigations. The book tries to bring out how to prolong life and how to conserve health. This will help individuals to maintain vitality and functional efficiency so that as they grow older they will not have so many handicaps to burden the later years of life. The book is well worth having by any student or research worker doing particular problems on growth and development as it brings out and discusses the problem of whether recently developed tissues and cells are more vulnerable and on that account need greater protection from strain and injury.

Excellent bibliographies are to be found at the end of each chapter. The last chapter is called **DOWN THROUGH THE AGES**. It is a collection of quotations selected from many authors dealing with age.

E. HIGBEE.

COLLEGE ZOOLOGY, 5th Edition by HEGNER, *Macmillan Company, New York.*

The illustrations in this edition are excellent and are of great help to the student. The colored plates add greatly to the book as they bring out details some students fail to learn for themselves from descriptions alone. The material is well organized and fol-

lows along in a logical manner. The text is easier to follow and the more popular style of presenting information helps the student to read along and really grasp the information presented. Well worth using as a text for College students and as a reference book for High School teachers of Biology.

SEX GUIDANCE IN FAMILY LIFE EDUCATION, by FRANCES BRUCE STRAIN. *Macmillan Company, New York.*

This book would be more worth while if the author eliminated the first four or five chapters and got down to the subject matter at once. One feels like putting the book down and not continuing to read to the end. It is only when one reaches the middle and reads from there to the end that the subject becomes interesting and points can be obtained which are of great use to the person teaching a course in sexual hygiene. Children, adolescents, and grown ups want to be given the facts in a simple and straight-forward manner. During this war emergency when things are happening so fast in the romantic life of our young people, teachers need books that give definite information without having to "wade through" so many unimportant sentences. As already stated the latter portion of the book is really worth while for the use of people attempting to teach this subject with any degree of success.

E. HIGBEE.

ULTRA-VIOLET LIGHT AND ITS APPLICATIONS by H. C. DAKE AND JACK DEMENT. *Published by Chemical Publishing Co., Inc., Brooklyn, New York. Price \$3.25.*

A book which should be of great use to police, military men, and scientists

in general. It does not deal with theories, but explains many of the practical applications of the use of ultra-violet light and fluorescence in the industries, arts, and sciences. The reading is smooth and everything is presented in such a simple, pleasing manner that even a layman could read the book with enjoyment. Well worth reading.

E. HIGBEE.

MANUAL OF WAR TIME HYGIENE
by SMILEY AND GOULD. *Macmillan Company.* Price \$1.00.

An excellent small manual for teaching hygiene, air raid duties, and first aid to soldiers or young men and women in the services of our country or those about to enter such service. Could also be used profitably by summer camps for either men or women.

E. HIGBEE.

LABORATORY DIRECTIONS IN COLLEGE ZOOLOGY by HENRY LANE BRUNER. *Macmillan Company.* Price \$1.75.

The material presented in this book has been arranged to follow the Phyla arrangement of the fourth edition of Hegner's College Zoology. The cell is studied first so that the student may familiarize himself with all important parts. The study of the phyla begins with the protozoa and ends with the Chordata giving a short survey on mitosis, tissues, organs and general embryology. The series of animals represented begins with a sponge and ends with a thorough study of the frog followed by a slightly less detailed work on the turtle and pigeon. A good laboratory text for any College course in General Zoology.

E. HIGBEE.



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